Membrane-Based X-band Radar Prototype for Research and Development

RE: Antenna Registration Question 4: Directional Antenna Information
File Number: 0911-EX-ST-2021
Confirmation Number: EL959052
Date: June 03, 2021

Experiment Overview

Systems & Technology Research (STR) is leading the effort to develop a radar payload for Air Force Space-Based Radar Payload Development Rapid Innovation Program (Air Force Prime Contract FA8726-20-C-0002). The goal of the program is to develop a preliminary design and a ground prototype for a future space-based radar. The radar antenna includes an innovative membrane-based reflectarray.

An integral part of the program is assembling and testing a scaled prototype that will demonstrate membrane reflectarray performance as well as overall radar system operation. This will be a ***ground-based*** prototype. The prototype will be transported to a desired collection location by truck, mounted and positioned, and then used for episodic (several days) data collection campaigns. We expect to track targets of opportunity, such as commercial aircraft and ground vehicles, as part of the data collections.

The experimental demonstration effort will be expected to begin in August 2021 and extend for 6 months. Depending on the preliminary results, we may file for an Experimental license to enable the effort to continue.

We request Special Temporary Authority (STA) for 9.2 GHz – 10.2 GHz frequency range. At a minimum we require a 200 MHz authority with center frequency between 9.8 GHz and 10.1 GHz to optimize our antenna performance. Outdoor testing and radiation is required to meet our contract objectives.

We request STA in two areas:

1. Massachusetts: 112 km radius circle around Boston Logan Airport (KBOS) (42° 21’ 46” N, 71° 00’ 23” W)
2. Colorado: 50 km radius circle around Berthoud, CO (40° 18’ 10’’ N, 105° 04’ 50” W).

For all computations below we consider the highest desired bandwidth and ERP of the systems in the band requested.

Radar Platform Description

The radar prototype is custom equipment currently being developed and tested. Overall 3D view of the equipment shown in Figure 1. The radar has a fixed elevation

(vertical) beam pointing and is capable of electronic scan in azimuth (horizontal plane) around a fixed boresite direction. Nominally, elevation boresite pointing will be between -10° and +15° elevation. Horizontal (azimuth) boresite pointing will depend on operational location and may be in range between 0° and 360°.

Figure 1. Radar Prototype.

Antenna Parameters

We are requesting authority to radiate from a single antenna system in frequency range between 9.2 GHz and 10.2 GHz. Expected instantaneous bandwidth will not exceed 800 MHz (objective). We can accommodate specific frequency notches, as appropriate for a given location.

The antenna is being custom-developed for this application and includes a phased array feed that is capable of electronic scanning in the azimuth direction while maintaining a fixed beam elevation. Peak gain of the antenna is 38.8 dB max over the requested frequency range. Peak transmit power will not exceed 144W. Resulting maximum EIRP is calculated to be 1.08 MW peak.

The transmission will be in Vertical polarization.

Calculated peak gain vs frequency is shown in Figure 4. Indoor range measurements with as-built prototype will be performed in July 2021.

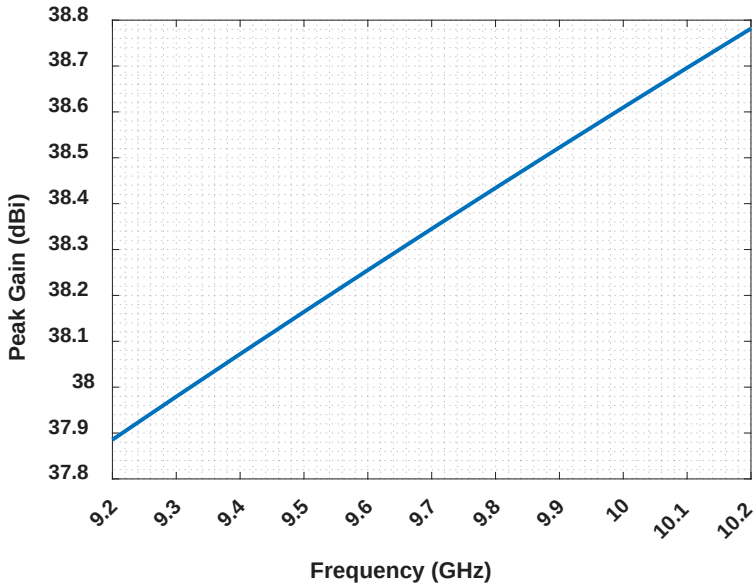

Figure 2. Calculated Peak Gain vs. Frequency

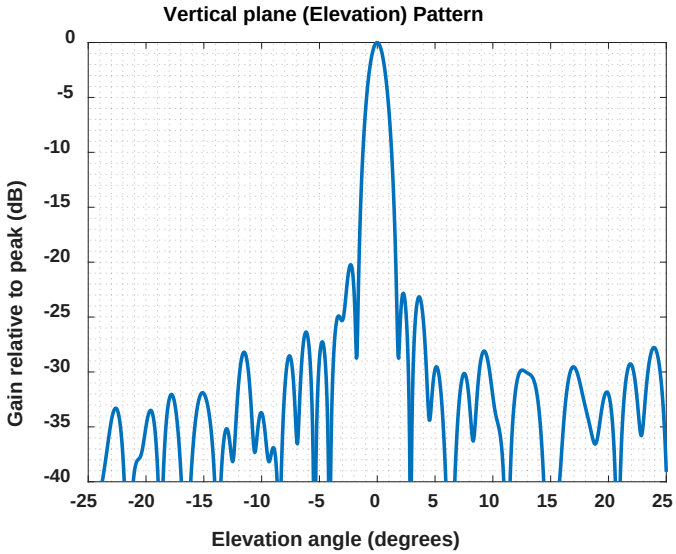

Figure 3. Vertical plane (Elevation) pattern relative to peak gain.

Simulated elevation (vertical plane) antenna pattern is shown in Figure 5. Half-power elevation beamwidth is 1.45 degrees. Elevation sidelobe level is approximately -30 dB.

Simulated azimuth (horizontal plane) antenna pattern is shown in Figure 6. Half-power azimuth beamwidth is 4.45 degrees. Near-in azimuth sidelobe level is approximately -30 dB, far out azimuth sidelobe level is expected to be lower. The antenna is back-baffled with a ground plane, so no significant backlobe radiation is expected.

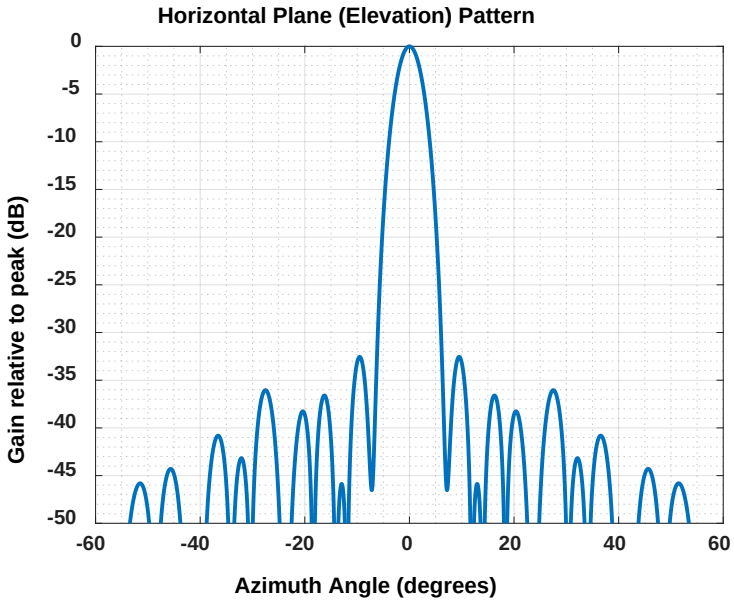

Figure 4. Horizontal plane (Azimuth) pattern relative to peak gain, at boresite steering angle

Summary of antenna properties is shown in Table 1.

Table 1. Summary of Antenna Properties

Parameter	Value
Frequency	9.2000 – 10.2000 GHz
Frequency tolerance	0.01 %
Output Power (W)	144 W
EIRP (W)	1.08 MW
Mean or Peak	Peak
Emission Designator	800MQ3N
Modulating Signal	Pseudo-noise
Instantaneous bandwidth	800 MHz (max)
Antenna gain	38.8 dB max
Antenna beam width (between –3dB points) - Azimuth	4.45°
Antenna beam width (between –3dB points) - Elevation	1.45°

Operations and Data Collection Locations

Massachusetts

STR plans to operate at various ground locations within 112 km radius from Boston Logan Airport, (KBOS, 42° 21' 46" N, 71° 00' 23" W, see Figure 5). The test events will not occur continuously, but rather as discrete test events during the execution of the contract. Any particular data collection is expected to last no more than 3 days.

Expected antenna pointing angles will be within the range of -10° to +15° in elevation and 0° to 360° in azimuth.

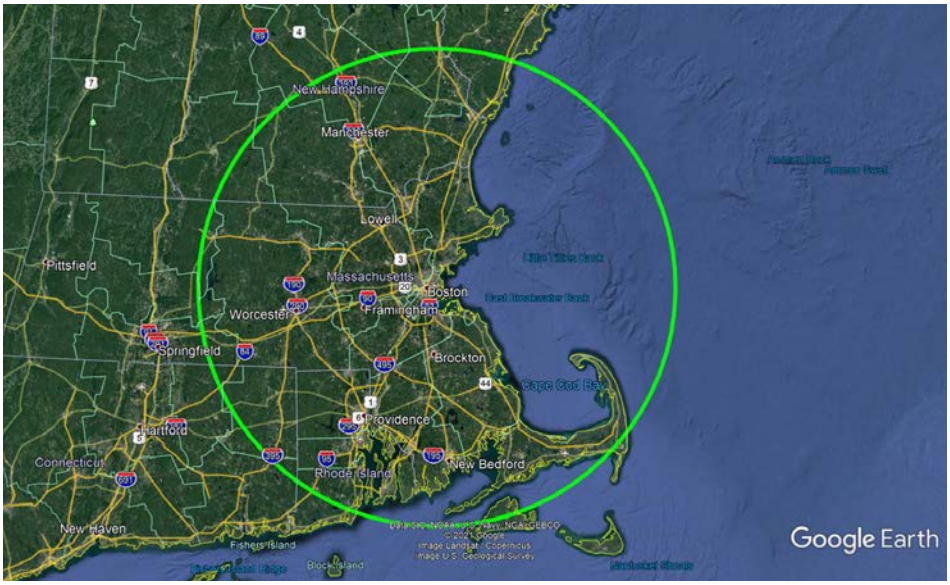

Figure 5. Operational Area Boundary in Massachusetts

Colorado

STR also plans to operate in several ground locations in the Berthoud, CO area, specifically within a 50 km radius of 40°18'10"N, 105°04'50"W (see Figure 6).

Expected antenna pointing angles will be within the range of -10° to +15° in elevation and 0° to 360° in azimuth.

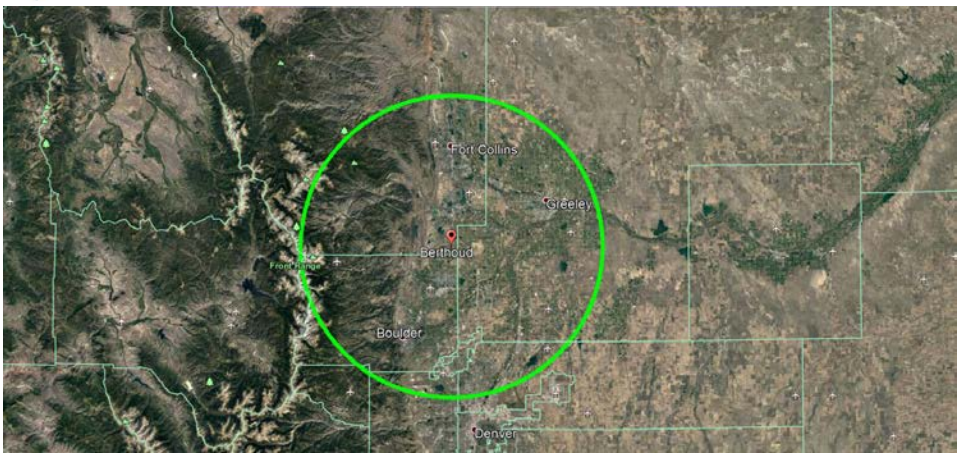

Figure 6. Operational Area Boundary in Colorado